

of its larger congener *X. furcatum*. The latter, owing to its restriction to the Pacific, has acquired some of the special characteristics of the Pacific Gulls : but there can be no doubt that these two surviving species of hooded *fork-tailed* Gulls must have had a common origin at no very remote period. The main factors in causing this approximation are, probably, the North-Pacific drift-current, which sweeps past the Aleutian Islands, down the coast of California to Mexico, at least as far as Acapulco ; and the cold Humboldt's current, abounding with fish, coming from the south and refreshing the coasts of Peru and the Galapagos. No greater contrast can be imagined than that between the vicinity of the Chincha Islands, swarming not only with Gulls and Terns, but with Gannets, Boobies, Pelicans, Cormorants, and Petrels literally by millions, and the comparatively unaviferous coast of Brazil in about the same latitude, say from Pernambuco to Bahia, along which a warm stream flows.

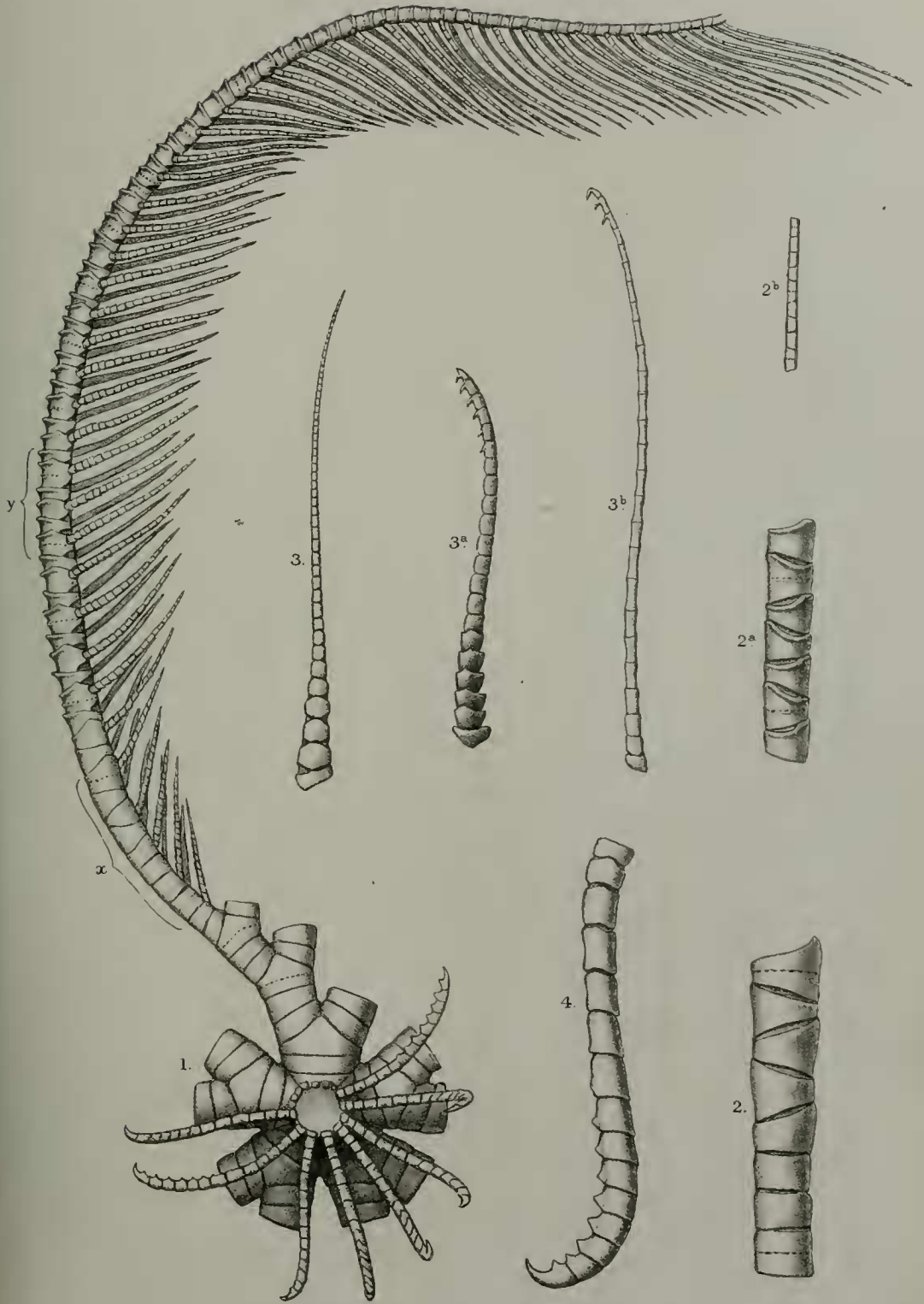
My heartiest thanks are due to Capt. Markham for the very interesting collection that has formed the subject for this paper ; would that in the navy there were more like him ! Every few years some of our men-of-war visit the Galapagos group ; but no attempt at a systematic exploration of the archipelago appears to have been made since the visits of the 'Adventure' and 'Beagle' in 1835 ; and that was in all probability owing, in a great measure, to the presence of the late Mr. Charles Darwin. It is almost certain that, if not only this group, but the other remote islands of the equatorial and northern Pacific were thoroughly explored, much important light would be thrown upon the distribution of species and the connexions which have existed between many which are now restricted either to the northern or to the southern hemisphere.

3. An Attempt to apply a Method of Formulation to the Species of the *Comatulidæ* ; with the Description of a new Species. By F. JEFFREY BELL, M.A., F.Z.S., Professor of Comparative Anatomy in King's College.

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(Plate XXXV.)

A zoologist who has been at work for a quarter of a century, more or less, and on whom the growth of zoological literature has been somewhat gradual, will hardly perhaps be greatly affected by the already enormous mass of descriptive and illustrative literature which appears in the journals of societies and other serial publications. The younger student, however, cannot look so calmly on the piles of papers that lie behind him, and the manifold sheets that are daily laid in his way.



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ACTINOMETRA ANNULATA.



If science is not to be overwhelmed by literature, an alternative is only to be found in such abbreviation as the mathematician, the physicist, and the chemist have already adopted, or in some form of the modern weapon, the *clôture*. It is unnecessary to insist on the advantage of the former.

Recognizing the force of these considerations, I proposed last year to this Society a method of formulating the results attained to, as regards our knowledge of the specific characters of the members of the genus *Asterias*. For the purpose of extending the process as much as possible, I select on this occasion a different group of the Echinodermata.

I cannot pass directly to the subject without expressing my satisfaction with the knowledge that Dr. Vosmaer, of Leyden, has invented a kind of short-hand for the description of Sponges, which will, I hope, bring him before long to a system of formulation.

When we make a general survey of the two genera which contain by far the greatest number of the Comatulidæ, *Antedon* and *Actinometra*, we note that,

(1) As a general rule, the arms are ten in number or more than ten; the joints before the first division are called *radials*, those before the second *distichals*; if there is a further division we shall have *palmars*; while the separate joints after the final division are known as the *brachials*.

(2) The leading differences between these sets of joints in different species are to be found in the varying arrangement of that mode of union to which Johannes Müller applied the term *syzygial*.

(3) The cirri on the centrodorsal vary in number, and in the number of their joints.

If (1) we use the letters *R*, *D*, *P* for the radials, distichals, and palmars respectively, and insert them in the formula whensoever the respective axillary is a syzygy, we may (2) distinguish which of the first three brachials (one of which is, with but very rare exceptions, a syzygy) is a syzygy by simply making use of the number 1, 2, or 3. Thirdly, the cirri and their number may be thus formulated: if there are from 1–12 cirri, we may say there are few; if from 12–30, a moderate number; and if more than 30, a large number: if there are not more than 20 joints to the cirri we may look upon them as being few, if from 20–40 moderate, and if more than 40 numerous. I propose to use the letters *a*, *b*, and *c* to represent few, moderate, and numerous respectively; while the letter for the number of cirri will form the numerator, and that for the number of joints the denominator of a fraction; and where there is a difficulty of decision one might write *ab* or *bc*.

*Antedon* and *Actinometra* may be usefully, though not of necessity, distinguished by making *A* or *A'* part of the formula.

One or two examples will explain the aim of this note. If we have a ten-rayed *Antedon* with 15 cirri of 40–50 joints, with its first syzygy on the third brachial, we may write its formula thus,  $3 A \frac{b}{c}$ ; so, again,

1 A'RP  $\frac{a}{c}$  is the formula for a multiradiate<sup>1</sup> *Actinometra* with its radial and palmar (though not its distichal) axillaries syzygies, with a syzygy on its first brachial, with less than 13 cirri, and more than 40 cirrus-joints.

When a character frequently though not always obtains, the corresponding letter is put within brackets: thus 3AR(P)  $\frac{a}{c}$  would be the formula of a species of *Antedon* in which, though the radial and third brachial joints were always syzygial, the palmar axillary was only sometimes so; in those rare cases in which divisions extend beyond the palmars, I have made use of the symbols *P'* and *P''*.

In the lists that follow, the greater number of described species of *Antedon* and *Actinometra* will be found enumerated and their formulæ given; in addition there are given the names and formulæ of some new forms that have been lately collected by Dr. Coppinger, of H.M.S. 'Alert,' the descriptions of which will be shortly published elsewhere.

As in the paper on *Asterias*, I have given only one reference to the description of each species. In addition to the heavy debt which I owe to the published writings of Mr. P. Herbert Carpenter, I have to add that the formulæ of some of the species of Johannes Müller are given with more satisfactory knowledge than the rest, owing to the fact that Mr. Carpenter, in a manner of which I know not whether the scientific liberality or the amiable friendliness is the more remarkable, has provided me with copies of the notes made by him on the specimens which formed the bases of Müller's descriptions. Mr. Herbert Carpenter's two papers referred to in the following lists are to be found (i.) in the 'Notes from the Leyden Museum,' vol. iii., and (ii.) in the 'Bulletin of the Museum of Compar. Zoology,' ix. no. 4. The references to Johannes Müller's 'Ueber die Gattung *Comatula*' refer to the pagination of the separate copies; Count Pourtales's papers are to be found in, respectively, (i.) Bull. M. C. Z. no. 6, (ii.) B. M. C. Z. no. 11, and (iii.) B. M. C. Z. v. no. 9. The other references will explain themselves.

## I. LISTS OF DESCRIBED SPECIES.

### (a) ANTEDON.

1. *adeonæ*, Müll. p. 15.
2. *alata*, Pourt. iii. p. 215.
3. *armata*, Pourt. ii. p. 356.
4. *articulata*, Müll. p. 27.
5. *vimaculata*, Carp. i. p. 186.
6. *brevicuneata*, Carp. i. p. 187.

<sup>1</sup> When D or P appear in a formula it is clear the species must have more than 10 rays, because of the meaning of the words those letters represent; where, however, neither distichals nor palmars present a syzygial joint, it will be necessary to make use of the mathematical sign for the square root to mark the fact of its being a multiradiate species.

7. *varinata*, Müll. p. 16.
8. *celtica*, Duncan and Sladen, Arctic Echinod. p. 75.
9. *cubensis*, Pourt. ii. p. 356.
10. *dubeni*, Bölsche, Arch. für Nat. 1866, p. 92.
11. *elongata*, Carp. i. p. 183.
12. *eschrichtii*, Duncan and Sladen, Arctic Echinod. p. 73.
13. *flagellata*, Carp. i. p. 183.
14. *granulifera*, Pourt. iii. p. 215.
15. *hageni*, Pourt. i. p. 111.
16. *jacquinoti*, Müll. p. 19.
17. *lavicirra*, Carp. i. p. 189.
18. *lavissima*, Grube, JB. schl. Ges. 1875, p. 74.
19. *mucronema*, Müll. p. 22.
20. *meridionalis*, Pourt. ii. p. 355.
21. *mertensi*, Grube, JB. schl. Ges. 1875, p. 74.
22. *milberti*, Müll. p. 19.
23. *milleri*, Müll. p. 15.
24. *palmata*, Müll. p. 25.
25. *perspinosa*, Carp. i. p. 178.
26. *petasus*, Müll. p. 17.
27. *phalangium*, Müll. p. 17.
28. *philiberti*, Müll. p. 23.
29. *pinniformis*, Carp. i. p. 180.
30. *prolixa*, Duncan and Sladen, Arctic Echinod. p. 77.
31. *reynaudi*, Müll. p. 23.
32. *rosacea*, W. B. Carpenter, Phil. Trans. 1866.
33. *rubiginosu*, Pourt. ii. p. 356.
34. *sarsi*, Müll. p. 18.
35. *savignii*, Müll. p. 21.
36. *serripinna*, Carp. i. p. 182.
37. *spicata*, Carp. i. p. 190.
38. *spinifera*, Carp. ii. p. 8.

(β) ACTINOMETRA.

1. *alternans*, Carp. i. p. 208.
2. *brachiolata (roseu)*, Müll. pp. 13, 14.
3. *bennetti*, Carp. i. p. 212.
4. *borneensis*, Grube, JB. schl. Ges. 1875, p. 74.
5. *echinoptera*, Müll. p. 14.
6. *fimbriata*, Müll. p. 22.
7. *japonica*, Carp. i. p. 202.
8. *jukesi*, Carp. Proc. Roy. Soc. 1879, p. 390.
9. *multifida*, Müll. p. 26.
10. *multiradiata*, Müll. p. 25.
11. *novæ-guineæ*, Carp. i. p. 193.
12. *parvicirra*, Carp. i. p. 204.
13. *peronii*, Carp. i. p. 214.
14. *pulchella*, Carp. ii. p. 10.
15. *robustipinna*, Carp. i. p. 201.
16. *rotalaria*, Müll. p. 20.

17. *schlegelii*, Carp. i. p. 210.  
 18. *solaris*, Müll. p. 12.  
 19. *trichoptera*, Müll. p. 21.  
 20. *typica*, Lovén, Öfv. K. Vet.-Akad. Förh. 1866, p. 231.  
 21. *wahlbergi*, Müll. p. 20.

In the succeeding lists the names are mentioned and the formulæ given of some new species from the Australian seas, full descriptions of which I hope to be able to publish at an early date.

## II. LISTS OF FORMULÆ.

### ANTEDON<sup>1</sup>.

adeonæ .....	$3A \frac{b}{b}$ .	lævicerria .....	$\sqrt{3A \frac{b}{b}}$ .
armata .....	$\times A \frac{b}{b}^*$ .	loveni .....	$3A \frac{b}{a}$ .
articulata .....	$\sqrt{3A \frac{c}{b}}$ .	macronema .....	$3A \frac{bc}{c}$ .
bimaculata .....	$\sqrt{3A \frac{c}{b}}$ .	microdiscus .....	$3ADP \frac{b}{c}$ .
brevicuneata .....	$\sqrt{3A \frac{b}{b}}$ .	milberti .....	$3A \frac{b}{b}$ .
briareus .....	$3AD \frac{b}{a}$ .	palmata .....	$3A \frac{b}{b}$ .
carinata .....	$3A \frac{b}{b}$ .	perspinosa .....	$3A \frac{a}{c}$ .
celtica <sup>2</sup> .....	$3A \frac{c}{b}$ .	phalangium .....	$3A \frac{b}{c}$ .
decipiens .....	$3AD \frac{b}{b}$ .	pinniformis .....	$3A \frac{a}{b}$ .
dubeni .....	$3A \frac{b}{ab}$ .	prolixa .....	$3A \frac{c}{c}$ .
elegans .....	$3AD(P) \frac{b}{c}$ .	reginæ .....	$\sqrt{3(5)A \frac{b}{b}}$ .
elongata .....	$\sqrt{3A \frac{b}{b}}$ .	reynaudi.....	$?3\sqrt{AR \frac{b}{c}}$ .
eschrichti .....	$3A \frac{c}{c}$ .	rosacea .....	$3A \frac{b^2}{a}$ .
flagellata .....	$\sqrt{3A \frac{b}{b}}$ .	sarsi .....	$\times A \frac{c}{ab}$ .
insignis .....	$3A \frac{b}{\times}$ .	savignii .....	$\times AD \frac{b}{b}$ .
irregularis .....	$3AD \frac{b}{b}$ .	serripinna .....	$3A \frac{a}{a}$ .
jacquinoti .....	$3A \frac{b}{b}$ .	spinifera.....	$\sqrt{\times A \frac{ab}{c}}$ .

<sup>1</sup> Several of the species of this genus and of *Actinometra* diagnosed by Count Pourtales are too briefly described for us to be able to include them in these lists.

\* The sign  $\times$  in a formula is to be understood to signify that information with regard to a certain character has not yet been obtained.

<sup>2</sup> Of Marenzeller and Sladen; see Zool. Anz. iv. p. 520.